PR-T-1

Before the
POSTAL REGULATORY COMMISSION
WASHINGTON, DC 20268-0001

Retail Access Optimization Initiative | Docket No. N2011-1

Testimony of

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Sponsored by the Public Representative
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I. Biography

Nigel Waters is a Professor in the Department of Geography and Geoinformation Science at George Mason University and the Director of the George Mason University Center of Excellence for Geographic Information Science. He obtained his PhD from The University of Western Ontario and has specialized in the use of Geographic Information System technology for the study of transportation systems and access to facilities. Relevant publications include:

Patel, A., Waters, N. M. & Ghali, W., 2007. Determining geographic areas and populations with timely access to cardiac catheterization facilities for acute myocardial infarction care in Alberta, Canada. *International Journal of Health Geographics*, 6 (47)

Tang, K.X., Waters, N.M., 2005. The Internet, GIS and Public Participation in Transportation Planning, *Progress in Planning*, 64 (1):1-62.

Waters, N.M., 2005. Transportation GIS: GIS-T, Chapter 59 in *Geographical Information Systems*, 2nd Edition, Abridged, Longley, P.A., Goodchild, M.F., Maguire, D.J. & Rhind, D.W.(eds.); Wiley, New York.

II. Purpose and Scope of Testimony

Evaluate the Postal Service's Docket No. N2011-1 RAOI proposal to close offices. Due to data and time limitations, the analysis in this testimony focuses on Kansas. In the future, this analysis should be performed for the entire country.

III. Supporting Library References

This testimony sponsors PR-LR-NP1. This library reference contains the databases and screenshots of the methodological steps in this research.

IV. Methodology

The analysis discussed in this report makes use of the industry leading Geographic Information Systems (GIS) software manufactured by the Esri company based in Redlands, California. This software is known as ArcGIS and for this analysis we used the latest version of the package which is known as ArcGIS 10.0, software that is used by the US Postal Service. ArcGIS allows us to store the locations of all the Post Offices in the United States in the GIS which is essentially a large spatial database. We also made use of other databases that included the US road network and population data from the US Bureau of the Census.

To demonstrate the effectiveness of our analysis we carried out a detailed analysis for the State of Kansas. Additional, similar analysis could be replicated for the remaining 49 states of the Union. The GIS software allowed us to look at the impact of closing post offices in Kansas. We were able to determine how the distance to a post office would be increased and how the area served would also be increased by post office closures. We were also able to examine the population characteristics of those residents that were in the most highly impacted areas. We were able to optimize the choice of post offices that would be closed and were able to show that the ArcGIS software could provide a better solution that had less of an impact on the population and allowed for more closures than those proposed by the Post Office. These solutions were better in terms of the service provided to the residents of Kansas.

V. Findings

The existing Kansas post office locations (n=647) were mapped with the ArcGIS 10 Geographic Information Systems (GIS) software and geographically projected using the following parameters:

Projected Coordinate System:	NAD83 State Plane Kansas South
Projection:	Lambert Conformal Conic

False Easting:	1312333.33333333
False Northing:	1312333.33333333
Central Meridian:	-98.50000000
Standard Parallel 1:	37.26666667
Standard Parallel 2:	38.56666667
Latitude of Origin:	36.66666667
Linear Unit:	US Foot
Geographic Coordinate System:	GCS North American 1983
Datum:	NAD 1983
Prime Meridian:	Greenwich
Angular Unit:	Degree

To estimate the service area coverage of each post office location before and after the proposed closures, the following analyses were conducted.

Thiessen polygons are polygons that are constructed around a set of points in a two dimensional space (one polygon for each point) such that any location inside a polygon is closer to the point contained by the polygon than any of the other points in the two dimensional space. Thiessen polygons can serve as a rough proxy for estimating the dimensions of facility service areas in geographic space. In this project, Thiessen polygons serve as simple estimations of the total service area for each Kansas post office location. Thiessen polygons were generated for each Kansas post office location before (Figures 1 and 2) and after (Figure 3) the proposed closures.

Figure 1: Thiessen polygons of post offices in Kansas prior to proposed closures. Polygons associated with proposed closures are shown in red.

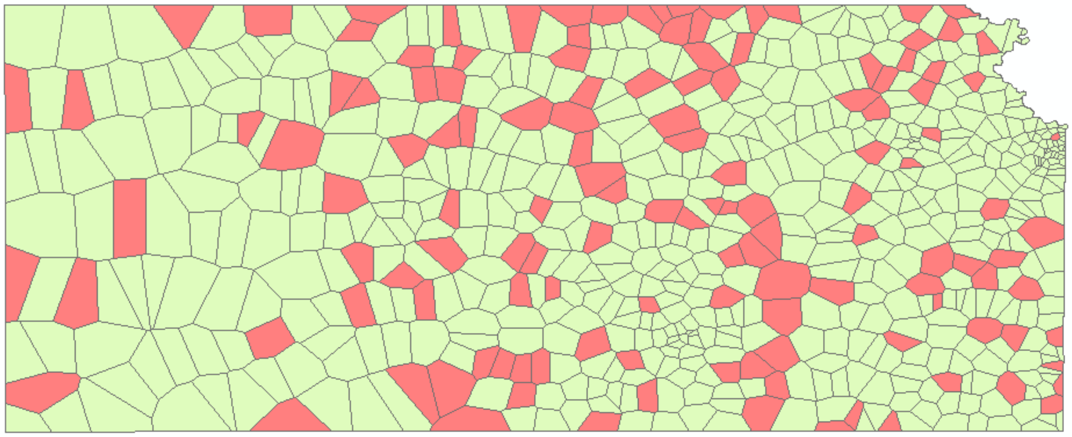


Figure 2: Post office locations and Thiessen polygons prior to proposed closures. Average service area before proposed closure: 127.7 square miles

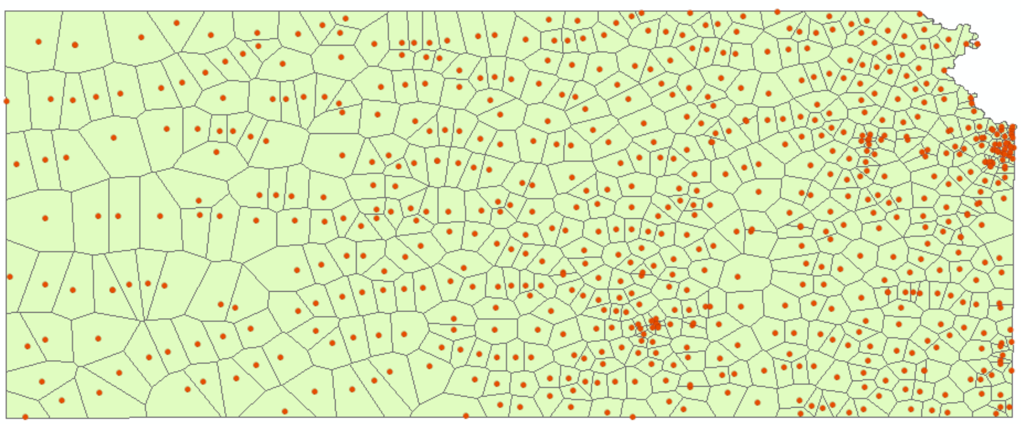
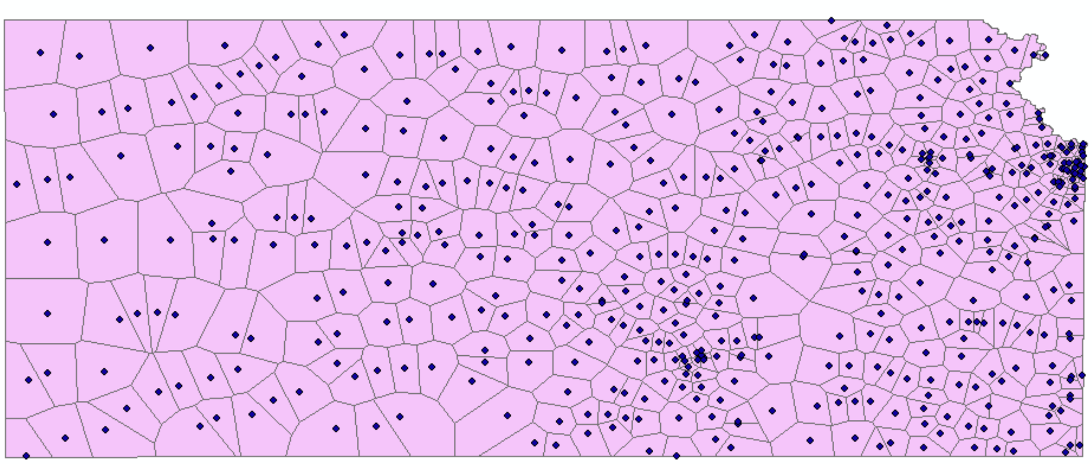


Figure 3: Post office locations and Thiessen polygons after the proposed closures. Average service area after proposed closure: 161.3 square miles



Discussion of Average Service Area results:

The average service area per post office in Kansas will increase 26% after proposed closures, from 127.7 square miles to 161.3 square miles (Figure 2 and Figure 3).

The mean population of post office service areas in Kansas before proposed closures is 4285 people. The mean population of post office service areas in Kansas after proposed closures will increase to 5271 people, an increase of 26%.

Getis-Ord Gi* Hot Spot Analysis

To determine where post office service area size will change significantly in space after the proposed closures in Kansas, a Getis-Ord Gi* Hot Spot Analysis of the Thiessen polygon size before and after closure was conducted. This analysis identifies statistically significant spatial clusters of large service areas (hot spots) and small service areas (cold spots).

Figure 4: Getis-Ord Gi* Hot Spot Analysis of Thiessen polygon size prior to proposed closures (top) and after proposed closures (bottom).

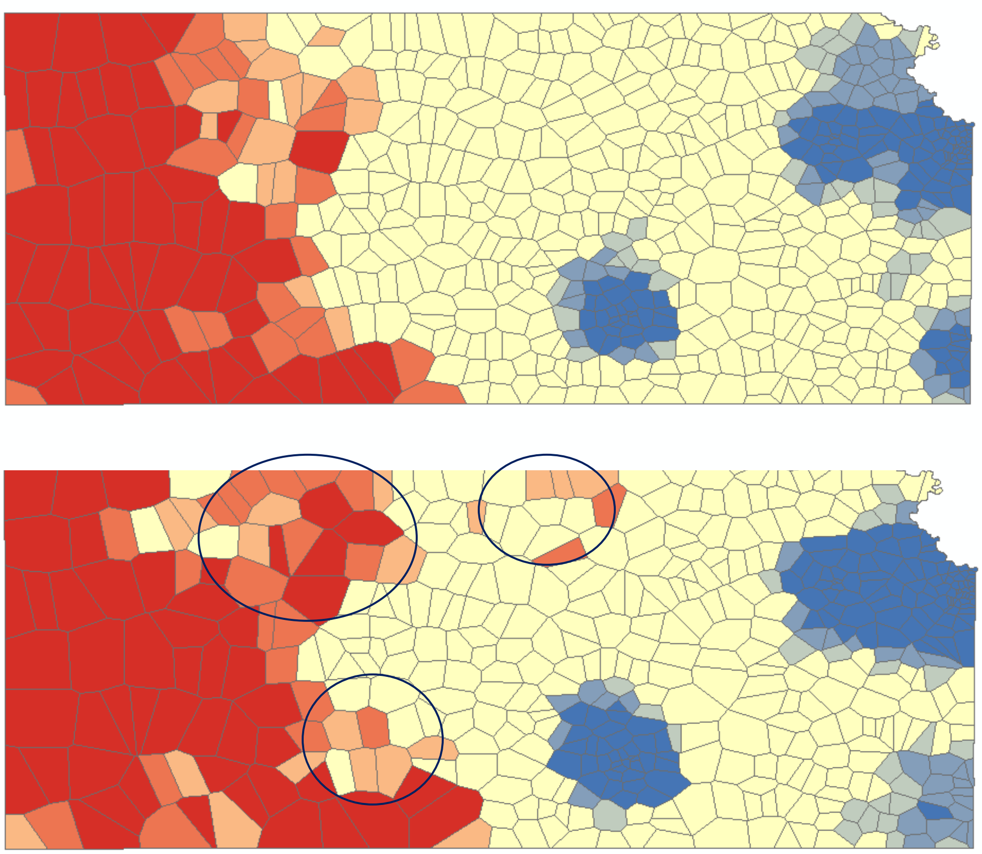


Figure 4 shows the emergence of new significant clusters of expanded service areas in the north and south-central portion of the state after the proposed closures (indicated by the blue ovals). The following examination of the socioeconomic dimensions of the proposed closures will focus on these new clusters of expanded service areas.

Demographic Analysis

A simple extraction of three population characteristics derived from the 2010 census was performed. The results are shown here both for the three regions and for Kansas as a whole in order to provide a comparison:

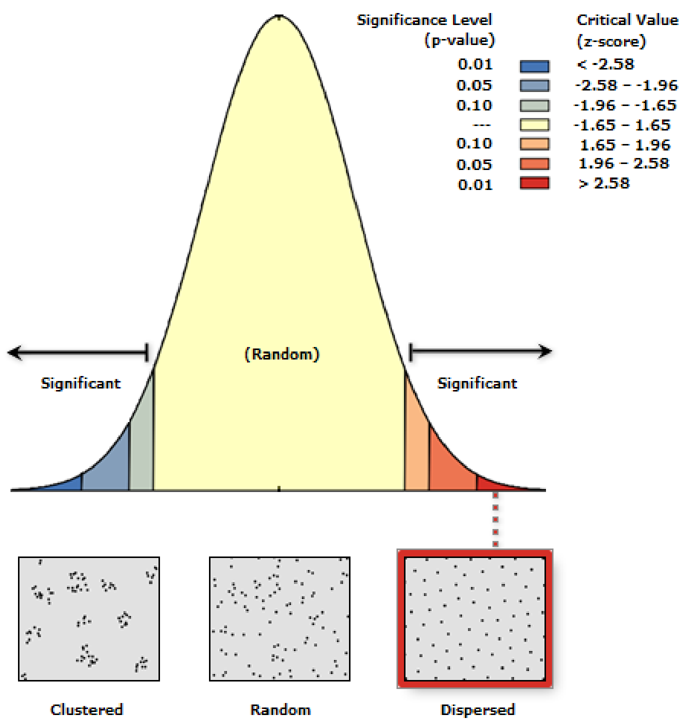
Average median age in the 3 regions:	42.8
Average median age in Kansas:	36.4
% housing rentals in the 3 regions	1.8%
% housing rentals in Kansas	2.8%
% households with children headed by a female in the 3 regions	3.8%
% households with children headed by a female in Kansas	6.0%

This simple analysis illustrates how a more complete analysis of the socioeconomic dimensions of the proposed closures can be accomplished. Additional data such as other demographic characteristics and also health, economic, education, and business variables would be necessary to fully explore this aspect of any proposed closures.

Average Nearest Neighbor Analysis (NNA)

An Average Nearest Neighbor Analysis (NNA) was calculated for the Kansas post office locations before and after proposed closures. This provides an estimate of the average Euclidean or straight line distance between a given location and its nearest neighboring post office. NNA also generates an estimate of the degree to which a set of locations is dispersed (evenly spaced) or clustered. The results are shown below:

Average Nearest Neighbor Summary Before Proposed Closures



Observed Mean Distance: 33728.52 feet or 6.3 miles

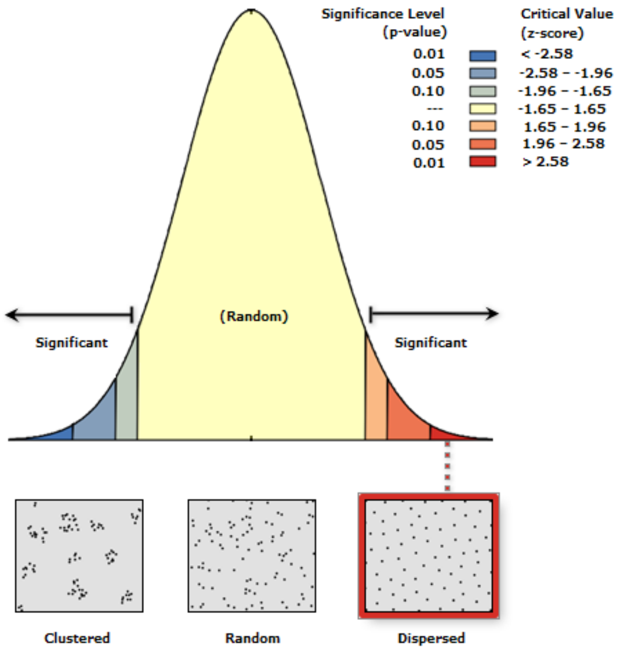
Expected Mean Distance: 29912 feet

Nearest Neighbor Ratio: 1.127582

z-score: 6.208312

p-value: 0.000000

Average Nearest Neighbor Summary After Proposed Closures



Observed Mean Distance:	35625.05 feet or 6.74 miles
Expected Mean Distance:	33479.568332 feet
Nearest Neighbor Ratio:	1.064083
z-score:	2.776736
p-value:	0.005491

The average Euclidean or straight line distance between neighboring post offices in Kansas prior to the proposed closures is approximately 6.3 miles. Dividing this value in half (3.15 miles) provides an estimate of the maximum distance that a patron would encounter when driving to the nearest post office prior to the proposed closures.

The average Euclidean distance between neighboring post offices in Kansas after the proposed closures is approximately 6.74 miles. Dividing this value in half (3.37

miles) provides an estimate of the maximum distance that a patron would encounter when driving to the nearest post office after the proposed closures.

Discussion of NNA results:

The increase in average maximum distance between post office locations in Kansas after the proposed closures represents a 7% increase in the maximum distance a patron would encounter when driving to the nearest post office.

The NNA z score (shown in the results above) is a statistical measure that helps the analyst determine if the distribution of post offices is concentrated or evenly spread out (dispersed). The latter is preferred since it provides more equable access to the post offices. The decrease in NNA z score from 6.2 to 2.7 after the proposed closures indicates that the post office locations in Kansas will be somewhat less evenly spread out than they were before the proposed closures but they will still be relatively, evenly spread out and this is what is desired.

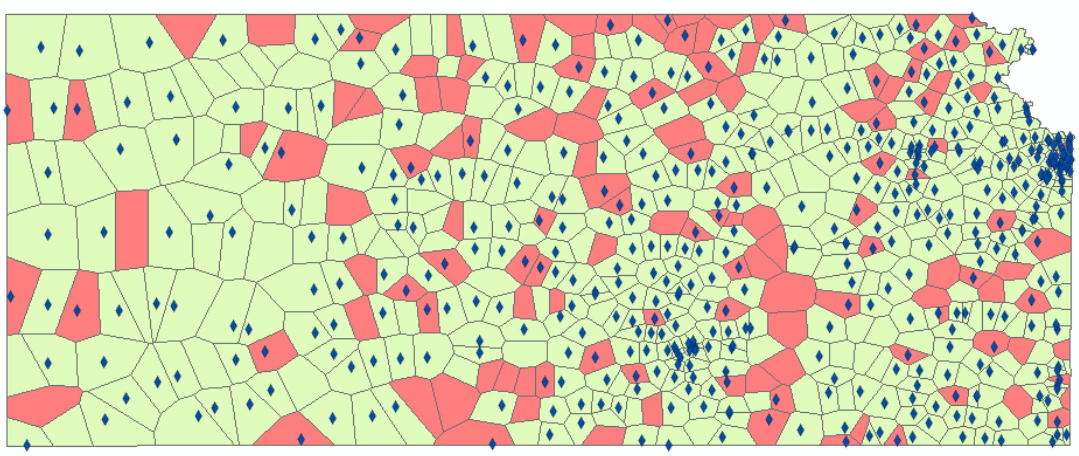
Location Allocation Analysis of proposed Post Office closures in Kansas

A Location Allocation (LA) analysis of the 647 post offices in Kansas was performed to evaluate how closely the proposed post office closures correspond with an optimized solution for post office locations in Kansas.

A p-median algorithm which minimizes the average distance to each post office was chosen from the ArcGIS software for the analysis (this is known as the "Minimize Impedance" solution). This method chooses an arrangement of post office facilities that minimizes the total weighted impedance or weighted distance to a post office in the network. The weighted distance is determined to be the population demand allocated to a post office facility multiplied by the total network distance to the post office. In this analysis the demand points are the census block groups in Kansas. The population of each block group serves as the weighted demand in the calculation. The analysis proceeded to determine the optimum location of 513 post offices in Kansas (the number of facilities remaining open after the proposed closures) based on this constraint.

Figure 5 is a comparison of the locations that are proposed to remain open (gray-green polygons) and the optimized locations (blue diamonds) determined by the analysis. The analysis determined that optimum coverage could be achieved with only 480 post offices in Kansas, suggesting that, based solely on minimizing total weighted population distance to the post offices, an additional 33 closures are possible.

Figure 5: Results of the Location Allocation Analysis. Red polygons are offices that are proposed for closure. Gray-green polygons are not proposed for closure. Blue diamonds are the optimized post office locations identified by the analysis.



There are 67 locations that are proposed for closure (exactly half of the 134 proposed closures) that were identified by the LA analysis as sites that should remain open. These are shown in Figure 5 as red polygons with a blue diamond.

This initial LA analysis reveals that based solely on minimizing population weighted impedance or distance, the recommended list of closures in Kansas is less than optimal, and a different set of closures would achieve a greater savings in travel time and travel distance encountered by potential post office patrons as measured by the general population in Kansas.

Suggestions for Further Analysis

Other types of spatial analysis that should be conducted in a comprehensive analysis of all proposed post office closures:

1. Accessibility analysis – from the perspective of the demand sites, future analysis should measure the spatial accessibility to post office locations and then map this information before and after the proposed closures.
2. Service area analysis should be completed based on network distance and physical barriers instead of Thiessen polygons used above.
3. More extensive analysis of the socioeconomic dimensions of the populations impacted by the proposed closures – this would involve a smoothing of the population variables using a statistical method known as kernel density smoothing (or a similar technique) prior to the spatial analysis.
4. Location Allocation analysis using other methodologies should be performed. This might include procedures known as algorithms that would maximize population coverage for a given number of facilities. This would allow a comparison of various different results with the list of proposed closures.

A fine scaled, more regionalized analysis of distances between post offices that examined rural only and urban only closures separately so as to remove the impact of one on the other.

VI. Conclusion

This report has demonstrated a methodology that can be used to inform the process of post office closure. This methodology required the use of the following databases: a list of proposed post office closures, population data from the US Census Bureau and a road network file. It also required the use of the ArcGIS 10 software.

Initial analysis of the proposed closures showed that the impact of the closures on the area served by each post office was relatively modest. Using Thiessen polygons to define service areas our analysis showed that the average service area per post office in Kansas will increase 26% after proposed closures, i.e. from 127.7 square miles to 161.3 square miles

Similar analysis showed that the increase in Nearest Neighbor distances between post offices caused by the proposed closures also was not large, only an increase from 6.3 miles to 6.74 miles. This means that the maximum increase in distance that a post office customer would have to travel is from 3.15 to 3.37 miles.

Three regions where the impact of post office closures was identified as being significantly greater were identified. For these regions three socio-economic variables were measured and compared to the values that exist state-wide. These three variables were median age, % housing rentals and % households headed by a female. The first variable was slightly higher for the regions more severely affected by closures, providing evidence of a slight impact on older residents. The second and third variables were slightly lower in the closure affected areas than in their state wide counterparts indicating that poorer members of the population were indeed less severely impacted by the closures.

The final analysis reported on here included a methodology for optimizing the closure process. This work, known as a location-allocation analysis, showed that if the primary goal was to minimize the average distance of the population served by its nearest post office then a much better solution could be obtained that would allow for more closures while still maintaining the same coverage. We recommend that such approaches, as outlined in the above analysis, should be used to determine future post office closures.

We also note that other approaches can be used in a location-allocation analysis and we recommend that these be explored in future work. For example, it is possible to develop location allocation models that minimize the population weighted distance and also include a maximum distance constraint so that no member of the public is more than a certain distance from a post office. We believe that such an approach has great merit for rationalizing the closure of post offices in the future. We also believe that such a maximum distance constraint would have to vary depending on population density. In other words in a rural area and in parts of the country where population density is low this maximum distance constraint would have to be greater than in locations where population density is high.

Any facility providing a service to the public can be considered in terms of Central Place Theory. This theory states that to be viable a service has to be able to capture a threshold population. Other things being equal, it captures all the population that is closer to it than to any other facility – in our case to any other post office. So post offices should be spaced evenly apart and not be located too close together for in such cases they will be competing for the same population. In Central Place Theory the distance that they should be separated is known as the range of the service. Post Offices are widely considered to be a low order service which means that they are ubiquitous because the threshold population needed to support them is relatively low. This is partly because members of the public need postal services on a regular basis and thus are unwilling to travel great distances for a service which is needed so frequently.

The Central Place Theory concepts of a threshold population and a range can be used to determine the appropriate population and maximum distance constraints that should be used in those location-allocation models that will need to be developed over the next five years to provide both an efficient and equitable closure of exiting post offices in the US.

As the use of postal services declines it is likely that the threshold population and the range or distance between post offices will need to gradually increase. Postal Services will essentially become higher order goods. There are two ways to ameliorate this trend. One is to provide new services that make the post office a service that is once again used on a frequent basis, thus returning it to a lower order service with a low threshold and range. A second strategy is to continue to develop alternate locations that exist within drugstores such as CVS and other businesses but that offer a wide range of postal services by post office employees. This strategy lowers the cost of operating postal services and again reduces the threshold population needed to support a post office.